

CLAIMS LISTING

1. -38. (canceled)

39. (currently amended) A method of transmission an incoming quadrature modulated optical signal receiving, comprising:

providing an optical device with first, second, third and fourth couplers, the two crossing waveguides, the phase shifter and four photodiodes [are] built on a single planar chip made of an electro-optical material; and wherein the optical device has four optical inputs and two electrical outputs;

applying a voltage to the first, second, third and fourth couplers to maintain a desired power splitting ratio[.]; and

applying offset voltages to the phase shifter to maintain a desired phase relationship between in-phase and in-quadrature electrical signals at an output of the optical device.

40. (canceled)

41. (canceled)

42. (currently amended) The method of claim [40]39, wherein the optical device includes a second phase shifter.

43. (previously presented) The method of claim 42, further comprising: controlling the first and second phase shifters to provide a desired phase relation of in-phase and in-quadrature signals.

44. (currently amended) The method of claim [40]39, further comprising, optimizing an average optical power at outputs of in-phase and in-quadrature signals.

45. (currently amended) The method of claim [41]39, wherein the optical device includes a feedback control loop.

46. (original) The method of claim 45, further comprising:

producing a voltage control signal and utilizing the feedback control loop to control the first, second, third and fourth couplers and the first phase shifter.

47. (original) The method of claim 45, wherein the optical device includes a processing device

that samples averaged in-phase and in-quadrature signals.

48. (original) The method of claim 46, further comprising: producing an error signal from sampling of the averaged in-phase and in-quadrature signals.

49. (original) The method of claim 44, wherein the optical device includes a converter device.

50. (original) The method of claim 49, further comprising: utilizing the converter device to provide rates that are at least equal to a bandwidth of a signal when averaging of data and processing is performed digitally.

51. (currently amended) The method of claim 39, wherein the transmission optical signal receiving [of] is in free space communications.

52. (currently amended) The method of claim 39, wherein the transmission receiving is applied to [with] a fiber communications.

53. (currently amended) The method of claim 39, wherein the transmission optical signal receiving is applied to a lidar application.

54. (currently amended) The method of claim 39, wherein the transmission optical signal receiving is utilized for spectral analysis.

55. (previously presented) An optical communication system for optical signal transmission in one polarization, comprising:

a transmitter; and

a quadrature modulated optical signal receiver, the receiver including:

a first adjustable coupler coupled to the first input and producing at least a first and second output;

a second adjustable coupler coupled to the second input and producing at least a first and second output;

a third adjustable coupler coupled to the first output of the first coupler and to the first output of the second coupler;

a fourth adjustable coupler coupled to the second output of the first coupler and to the second output of the second coupler; electrodes providing said tuning of the first, second, third, and fourth couplers;

first and second crossing waveguides with an angle selected to minimize crosstalk and losses between the first and second cross waveguides, the first crossing waveguide connecting one of the first or second outputs from the first coupler with an input of the fourth coupler, the second crossing waveguide connecting one of the first or second outputs from the second coupler with an input of the third coupler;

a first phase shifter coupled to the first and second waveguides, the first and second waveguide being connected to one of the outputs of the first or second coupler and one of the inputs of the third or fourth coupler,

photodiodes converting optical signal into electrical signal; wherin the first, second, third and fourth couplers, the two crossing waveguides and the phase shifter and photodiodes are each formed as part of a single planar chip made of an electro-optical material.

56. (original) The system of claim 55, wherein the transmitter comprises: a first Mach-Zehnder modulator that produces a first output; a second Mach-Zehnder modulator that produces a second output; a splitter coupled to the first and second Mach-Zehnder modulators; a combiner that combines the first and second outputs; and a phase shifter coupled to the first and second Mach-Zehnder modulators, wherin the first Mach-Zehnder modulator, the second Mach-Zehnder modulator, the splitter, the combiner and the phase shifter are formed as part of a single planar chip made of electro-optical material.

57. (original) The system of claim 56, wherein the single planar chip is a single piece of crystal.

58. (original) The system of claim 56, wherein the chip is made of a material selected from LiNbO₃ or LiTaO₃.

59. (original) The system of claim 56, wherein the chip is made of LiNbO₃ or LiTaO₃ cut at X, or Y, or Z planes.

60. (original) The system of claim 56, wherein the splitter is a Y-junction.

61. (original) The system of claim 56, wherein the splitter is a waveguide coupler.

62. (original) The system of claim 56, wherein the combiner is a Y-junction.

63. (original) The system of claim 56, wherein the combiner is a waveguide coupler.

64. (original) The system of claim 56, wherein the first Mach-Zehnder modulator includes a first biasing electrode, and the second Mach-Zehnder modulator includes a second biasing electrode.

65. (original) The system of claim 56, further comprising: a first bias electrode coupled to the first Mach-Zehnder modulator; and a second bias electrode coupled to the second Mach-Zehnder modulator.

66. (previously presented) The system of claim 65, wherein each of the first and second bias electrode are a push-pull configuration.

67. (original) The system of claim 65, wherein the first and second bias electrode are configured to optimize a DC bias point of the first and second Mach-Zehnder modulators

68. (original) The system of claim 56, wherein the splitter is adjustable.

69. (original) The system of claim 56, wherein the combiner is adjustable.

70. (original) The system of claim 56, wherein each of the first and second Mach-Zehnder modulators is a push-pull configuration.

71. (original) The system of claim 56, wherein the splitter is positioned at an input of the system, and the combiner is positioned at an output of the device.
72. (original) The system of claim 56, wherein the splitter and combiner are 3-dB devices.
73. (original) The system of claim 56, wherein each of the first and second Mach-Zehnder modulators is driven by an RF signal.
74. (original) The system of claim 56, wherein the system includes at least a first and a second waveguide each associated with one of the first and second Mach-Zehnder modulators.
75. (original) The system of claim 56, wherein the waveguides of the first and second Mach-Zehnder modulators are coplanar to each other.
76. (original) The system of claim 56, further comprising: a phase shifter with a third bias electrode coupled to each of the first and second Mach-Zehnder modulators and configured to provide an adjustable 90-degree phase difference between outputs from first and second Mach-Zehnder modulators.
77. (original) The system of claim 76, wherein the phase shifter is a push-pull configuration.
78. (original) The system of claim 56, wherein the splitter divides an input beam into substantially equal first and second beams that are directed to the first and second Mach-Zehnder modulators.
79. (original) The system of claim 56, wherein each of the first and second Mach-Zehnder modulators are independently modulatable.
80. (original) The system of claim 56, wherein the electro-optical material is a crystal made of a material selected from LiNbO₃ or LiTaO₃, with a cut at X, Y, or Z planes relatively

to an axis of the crystal.

81. (original) The system of claim 56, wherein indifussed metal technology is used with the electro-optical material includes.

82. (previously presented) The system of claim 56, wherein photonic-exchange optical technology is used with the electro-optical material includes.

83. (original) The system of claim 56, wherein etching optical technology is used with the electro-optical material.

84. (original) The system of claim 56, wherein milling optical technology is used with the electro-optical material.

85. (original) The system of claim 56, whercin the electro-optical material includes a substrate coated with a buffer.

86. (original) The system of claim 57, wherein the buffer is silicon dioxide.

87. (original) The system of claim 55, further comprising: a multiplexer coupled to the transmitter and receiver.

88. (original) The system of claim 55, further comprising: an optical repeater coupled to the transmitter and receiver.

89. (original) The system of claim 55, further comprising: an amplifier coupled to the transmitter and receiver.

90. (original) The system of claim 55, further comprising: a filter coupled to the transmitter and receiver.

91. (original) The system of claim 55, wherein the transmitter comprises: a first Mach-Zehnder modulator that produces a first output; a second Mach-Zehnder modulator that produces a second output; a third Mach-Zehnder modulator that produces a third output; a fourth Mach-Zehnder modulator that produces a fourth output; a first input splitter coupled to the first and second Mach-Zehnder modulators; a first phase shifter coupled to the first and second outputs; a first output combiner positioned to combine the first and second outputs from the first and second Mach-Zehnder modulators; a second input splitter coupled to the third and fourth Mach-Zehnder modulators; a second phase shifter coupled to the third and fourth outputs; and a second output combiner positioned to combine the third and fourth outputs.

92. (original) The optical device of claim 91, wherein the first, second, third and fourth Mach-Zehnder modulators, the first and second input splitters, the first and second phase shifters, and the first and second output splitters are formed as part of a chip made of electro-optical material.

93. (original) The optical device of claim 91, further comprising: a third input splitter coupled to the first and second input splitters.